

WHAT IS CLAIMED IS:

1. A method of embedding watermark information in master data, said method comprising the steps of:

5 (a) causing the master data to be subjected to discrete Fourier transform;

10 (b) adding a minute variation, which corresponds to a phase difference pattern determined in advance as the watermark information, to either one of a real number array and an imaginary number array of the master data obtained by the discrete Fourier transform, so as to generate resulting data with the minute variation added thereto; and

15 (c) causing the resulting data with the minute variation added thereto to be subjected to inverse Fourier transform, so as to generate authorized data with the watermark information embedded therein.

20 2. A method in accordance with claim 1, wherein said step (b) adds a minute variation  $\Delta F$  to a spectrum  $F(m,n)$  of a specific frequency  $(m,n)$  in either one of the real number array and the imaginary number array.

25 3. A method in accordance with claim 2, wherein said step (b) carries out the addition of the minute variation  $\Delta F$  while keeping symmetry of either one of the real number array and the imaginary number array.

4. A method in accordance with claim 3, wherein the minute variation added is within a range of 2 to 10% of the spectrum.

5           5. A method in accordance with claim 1, wherein either one of the real number array and the imaginary number array, to which the minute variation is added in said step (b), is a component in a low frequency domain.

10           6. A method in accordance with claim 1, said method further comprising steps of:

15           (a0) causing the master data to be subjected to a predetermined data transform, which converts the master data to a specific data form that enables an area mainly corresponding to a low frequency component to be specified, prior to the discrete Fourier transform in said step (a); and

            (ax) carrying out an inverse transform of the predetermined data transform performed in said step (a0), after the inverse Fourier transform in said step (c),

20           wherein said step (a) causes a specific data portion, which represents the area mainly corresponding to the low frequency component and is selected out of the data converted in said step (a0), to be subjected to the discrete Fourier transform.

25           7. A method in accordance with claim 6, wherein the data compression and the inverse transform of the data compression are

wavelet transform and inverse wavelet transform.

8. A method in accordance with claim 1, wherein the master data is two-dimensional image data.

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9. A method of detecting embedded watermark information when there is authorized data, which is obtained by embedding the watermark information in master data according to the embedding method in accordance with claim 1, said detecting method comprising the steps of:

taking out a difference between the master data and the authorized data as a phase difference pattern; and

detecting the phase difference pattern as a digital watermark of the authorized data.

10. A method of detecting embedded watermark information when there is authorized data, which is obtained by embedding the watermark information in master data according to the embedding method in accordance with claim 6, said detecting method comprising the steps of:

causing the master data to be subjected to the predetermined data transform of said step (a0);

causing the authorized data to be subjected to the predetermined data transform of said step (a0);

taking out a difference between the transformed master data and the transformed authorized data as a phase difference pattern;

and

detecting the phase difference pattern as a digital watermark of the authorized data.

5 11. A method of identifying a phase difference pattern W1 that is watermark information embedded in master data P0, when there is data Pi obtained by embedding other phase difference patterns Wi (i= 2,3,...) in authorized data P1 as watermark information a plurality of times according to the embedding method in accordance with claim 1, where the authorized data P1 is obtained by legally embedding the phase difference pattern W1 in the master data P0 as the watermark information, said identifying method comprising the steps of:

10 (d) taking out a difference between the master data P0 and the data Pi with the other phase difference patterns embedded therein the plurality of times;

15 (e) taking out a difference between the authorized data P1 and the data Pi with the other phase difference patterns embedded therein the plurality of times; and

20 (f) extracting an eventual difference between the difference taken out in said step (d) and the difference taken out in said step (e) as the legal phase difference pattern W1.

25 12. A method of identifying a phase difference pattern W1 that is watermark information embedded in practical master data Q0, when there is data Qi obtained by embedding other phase

difference patterns  $W_i$  ( $i = 2, 3, \dots$ ) in authorized data  $Q_1$  as watermark information a plurality of times according to the embedding method in accordance with either one of claims 1<sup>✓</sup> and 6,<sup>✓</sup> where the authorized data  $Q_1$  is obtained by converting master data  $P_0$  to a specific data form that enables an area mainly consisting of a low frequency component to be specified and then legally embedding the phase difference pattern  $W_1$  in the area as the watermark information, said identifying method comprising the steps of:

(g) taking out a difference between the practical master data  $Q_0$  and the data  $Q_i$  with the other phase difference patterns embedded therein the plurality of times;

(h) taking out a difference between the authorized data  $Q_1$  and the data  $Q_i$  with the other phase difference patterns embedded therein the plurality of times; and

(i) extracting an eventual difference between the difference taken out in said step (g) and the difference taken out in said step (h) as the legal phase difference pattern  $W_1$ .

13. An apparatus for embedding watermark information in master data, said apparatus comprising:

a transform unit that causes the master data to be subjected to discrete Fourier transform;

a phase difference pattern addition unit that adds a minute variation, which corresponds to a phase difference pattern determined in advance as the watermark information, to either one

of a real number array and an imaginary number array of the master data obtained by the discrete Fourier transform, so as to generate resulting data with the minute variation added thereto; and

an inverse Fourier transform unit that causes the resulting data with the minute variation added thereto to be subjected to inverse Fourier transform, so as to generate authorized data with the watermark information embedded therein.

14. An apparatus for embedding watermark information in master data, said apparatus comprising:

a data transform unit that causes the master data to be subjected to a predetermined data transform, which converts the master data to a specific data form that enables an area mainly corresponding to a low frequency component to be specified;

a transform unit that causes a specific data portion corresponding to the area out of the converted data to be subjected to discrete Fourier transform;

a phase difference pattern addition unit that adds a minute variation, which corresponds to a phase difference pattern determined in advance as the watermark information, to either one of a real number array and an imaginary number array of the specific data portion obtained by the discrete Fourier transform, so as to generate resulting data with the minute variation added thereto;

an inverse Fourier transform unit that causes the resulting data with the minute variation added thereto to be subjected to inverse Fourier transform; and

an inverse transform unit that causes the resulting data, which has undergone the inverse Fourier transform, as well as a residual data portion corresponding to a residual area to be subjected to an inverse transform of the predetermined data transform, so as to generate authorized data with the watermark information embedded therein.

15. A storage medium in which a specific program used to embed watermark information in master data is stored in a computer readable manner, said specific program causing a computer to attain the functions of:

inputting the master data;

causing the input master data to be subjected to discrete Fourier transform;

adding a minute variation, which corresponds to a phase difference pattern determined in advance as the watermark information, to either one of a real number array and an imaginary number array of the master data obtained by the discrete Fourier transform, so as to generate resulting data with the minute variation added thereto; and

causing the resulting data with the minute variation added thereto to be subjected to inverse Fourier transform, so as to generate authorized data with the watermark information embedded therein, and outputting the authorized data.

16. A storage medium in which a specific program used to

embed watermark information in master data is stored in a computer readable manner, said specific program causing a computer to attain the functions of:

inputting the master data;

5 causing the master data to be subjected to a predetermined data transform, which converts the master data to a specific data form that enables an area mainly corresponding to a low frequency component to be specified;

10 causing a specific data portion corresponding to the area out of the converted data to be subjected to discrete Fourier transform;

15 adding a minute variation, which corresponds to a phase difference pattern determined in advance as the watermark information, to either one of a real number array and an imaginary number array of the specific data portion obtained by the discrete Fourier transform, so as to generate resulting data with the minute variation added thereto;

causing the resulting data with the minute variation added thereto to be subjected to inverse Fourier transform; and

20 causing the resulting data, which has undergone the inverse Fourier transform, as well as a residual data portion corresponding to a residual area to be subjected to an inverse transform of the predetermined data transform, so as to generate authorized data with the watermark information embedded therein.